

WHAT IS CLAIMED IS:

1. An apparatus for imaging, the comprising:  
at least one source of composite radiation illuminating a field of view, the radiation comprising a set of multiple phase-independent partials being independently controllable and exhibiting distinct physical features;  
a quasi-optical element disposed between the field of view and a multi-element receiver; and  
the multi-element receiver disposed to receive image radiation from the quasi-optical element, wherein particular ones of the receiver elements transform the image radiation into a set of electrical signals including information relating to features of the partials.
2. The apparatus of claim 1 wherein the at least one source of composite radiation includes an encoder configured to label each of the partials with a unique code.
3. The apparatus of claim 2 wherein each distinct partial is labeled with a distinct unique code.
4. The apparatus of claim 2 and further comprising decoder to extract the information relating to the features of the partials from the electrical signals.
5. The apparatus of claim 1 and further comprising a processor coupled to receive the electrical signals from the receiver, the processor to generate a resultant image from the electrical signals.
6. The apparatus of claim 1 wherein the partials within the set of partials differ from each other by angles of propagation in the field of view.
7. The apparatus of claim 6 wherein partials of the set exhibit first characteristic polarization.

8. The apparatus of claim 1 and further comprising a polarizer coupled between the at least one source of composite radiation and the multi-element receiver.

9. The apparatus of claim 1 wherein the at least one source of composite radiation generates radiation having a wavelength between about 0.1mm and about 10mm.

10. An apparatus for imaging, the apparatus comprising:  
means for illuminating a field of view with composite radiation, the radiation comprising a set of multiple phase-independent partials being independently controllable and exhibiting distinct physical features;  
quasi-optical means for forming images of the field of view; and  
multi-element receiving means for receiving image radiation from the quasi-optical means, wherein the receiving means including means for transforming the image radiation into a set of electrical signals including information relating to features of the partials.

11. An s-mmw imaging system, comprising  
a non-rotating diffuser destroying a spatial coherence of radiation incident on the diffuser and directing the radiation towards a field of view;  
at least one radiation source disposed to illuminate the diffuser, the at least one radiation source generating radiation having a wavelength between about 0.1mm and about 10mm;  
a quasi-optical element disposed between the field of view and a multi-element receiver, the quasi-optical element directly radiation from the field of view toward an imaging plane; and  
a multi-element receiver disposed in the imaging plane, wherein particular ones of the receiver elements transform radiation into a set of electrical signals.

12. The system of claim 11 wherein the diffuser comprises a spatially distributed diffuser.

13. The system of claim 12 wherein the diffuser comprises a plurality of spatially distributed point scatterers.
14. The system of claim 13 wherein the diffuser comprises a two-dimensional array of point scatterers, each of the point scatterers having a position and orientation which can be independently changed in time relative to a reference plane.
15. The system of claim 13 wherein the point scatterers comprise conductive structures being loaded by impedances.
16. The system of claim 13 and further comprising a processor coupled to receive the electrical signals from the receiver, the processor causing the point scatterers to be controlled based on information determined from the electrical signals.
17. The system of claim 11 and further comprising a processor coupled to receive the electrical signals from the receiver, the processor generating resultant images from the electrical signals.
18. The system of claim 11 wherein the radiation directed from the diffuser toward the field of view comprises a set of multiple phase-independent partials being independently controllable and exhibiting distinct physical features and wherein the electrical signals include information relating to features of the partials.
19. The system of claim 11 wherein the radiation incident on the diffuser includes doublet spectral components.
20. The system of claim 19 wherein the radiation incident on the diffuser is modulated by modulating a spectral shift between doublet spectral components.
21. An imaging system comprising  
at least one source of partially coherent radiation for illuminating a field of view;

an electronic device coupled providing electrical control signals to the at least one source, the electrical control signals controlling the level of coherence of the partially coherent radiation;

a quasi-optical element disposed between the field of view and an imaging plane;  
and

a multi-element receiver disposed in the imaging plane to receive image radiation from the quasi-optical element, wherein particular ones of the receiver elements transform the image radiation into a set of electrical signals.

22. The system of claim 21 wherein the electrical control signals control the level of spatial coherence of the partially coherent radiation.

23. The system of claim 21 wherein the electrical control signals control the level of temporal coherence of the partially coherent radiation.

24. The system of claim 21 wherein the at least one source comprises a radiation source and a diffuser disposed to received radiation from the radiation source, the diffuser including a plurality of spatially-distributed and electronically-controllable point scatterers.

25. The system of claim 24 wherein the point scatterers comprise conductive structures that are loaded by impedances and wherein the magnitudes of the impedances are time-varied due to modulation.

26. The system of claim 25 wherein the point scatterers are divided into sets and wherein each point scatterer within a set of point scatterers is modulated in the same manner.

27. A method of illuminating a field of view, the method comprising:  
generating radiation with a wavelength greater than about 0.1mm, the radiation including multiple phase-independent partial components exhibiting distinguishable physical features;

encoding the radiation to label different ones of the multiple partial components;  
directing the radiation toward a field of view;  
focusing the radiation on an imaging plane;  
detecting the radiation from the imaging plane;  
converting the radiation into electrical signals; and  
extracting information relating to features of the multiple partial components from  
the electrical signals.

28. The method of claim 27 wherein the multiple partial components comprises radiation components with different angles of incidence relative to the field of view.

29. The method of claim 27 wherein the multiple partial components comprises radiation components with different central frequencies.

30. The method of claim 27 wherein the multiple partial components comprises radiation components with different polarization characteristics.

31. The method of claim 27 wherein the step of encoding comprises modulating to label different ones of the multiple partial components.

32. The method of claim 27 wherein the radiation comprises at least one spectral doublet.

33. The method of claim 27 and further comprising modifying the electrical signals based upon the information extracted relating to the features of the multiple partial components.

34. The method of claim 27 wherein extracting includes decomposing the electrical signals based on the partial components.

35. A source of partially coherent radiation for illuminating a field of view, the source comprising:

at least one non-movable diffuser destroying a spatial coherence of radiation being incident on the diffuser and directing the radiation towards a field of view; and

at least one radiation emitting source being arranged to illuminate said diffuser with radiation having a wavelength between about 0.1mm and about 10mm.

36. The source of partially coherent radiation of claim 35 wherein said non-movable diffuser comprises a spatially distributed diffuser.

37. The source of partially coherent radiation of claim 35 wherein the diffuser includes an array of independently controllable radiation scatterers.

38. The source of partially coherent radiation of claim 37 wherein each of the radiation scatterers is electronically controllable by a time-varying modulation signal.

39. A source of partially coherent radiation for illuminating a field of view, the source comprising:

at least one non-movable diffuser destroying a spatial coherence of radiation being incident on the diffuser and directing the radiation towards a field of view, the diffuser including an array of spatially distributed antennae; and

at least one radiation emitting source being arranged to illuminate said diffuser with radiation.

40. The source of partially coherent radiation of claim 39 wherein the diffuser includes an array of independently controllable radiation scatterers.

41. The source of partially coherent radiation of claim 40 wherein each of the radiation scatterers is electronically controllable by a time-varying modulation signal.

42. The source of partially coherent radiation of claim 39 wherein the at least one radiation emitting source arranged to illuminate the diffuser with radiation having a wavelength between about 0.1mm to about 10mm.
43. The source of partially coherent radiation of claim 39 wherein the diffuser includes an array of spatially distributed point scatterers, each point scatterer comprising a conductive structure loaded by an impedance.
44. A source of partially coherent radiation for illuminating a field of view, the source comprising:  
at least one non-movable diffuser destroying a spatial coherence of radiation being incident on the diffuser and directing the radiation towards a field of view, the diffuser including an array of independently controllable radiation scatterers; and  
at least one radiation emitting source being arranged to illuminate said diffuser with radiation.
45. The radiation source of claim 44 wherein each of the radiation scatterers is electronically controllable.
46. The radiation source claim 45 wherein each of the radiation scatterers is controllable by a time-varying modulation signal.
47. The radiation source of claim 46 wherein radiation scatterers are assigned into sets and wherein each radiation scatterer within a set of radiation scatterers is modulated in the same manner.
48. The radiation source of claim 44 wherein the radiation scatterers can be independently controlled by physically moving the point scatterers with respect to a reference plane.

49. The radiation source of claim 44 wherein each radiation scatterer comprises a conductive structure loaded by an impedance.

50. The radiation source of claim 44 wherein each radiation scatterer comprises a static high-Q resonant scatterer exhibiting frequency resonance belonging to a particular frequency band and wherein the radiation emitting source comprises a radiation source that sweeps over the particular frequency band.

51. The radiation source of claim 44 wherein the at least one radiation emitting source is arranged to illuminate the diffuser with radiation having a wavelength between about 0.1mm to about 10mm.

52. A millimeter wave system comprising:

a source of radiation, the radiation comprising a set of independently controllable radiation components, each radiation component comprising a doublet that includes two spectral lines, and each radiation component being labeled by a given frequency shift between the two spectral lines;

a receiver including an array of receiver elements disposed to receive the radiation emitted by the source, the receiver transforming the received radiation into an array of electrical signals; and

a processing system coupled to receive the array of electrical signals and for decoding the array of electrical signals based on the labels of the radiation components.

53. The system of claim 52 wherein the processing system is coupled to the source of radiation to provide instructions on how to control the radiation components.

54. The system of claim 52 wherein the frequency difference between the two spectral lines is modulated.

55. The system of claim 52 wherein the central frequency of the two spectral lines is swept in time.



56. The system of claim 52 wherein the two spectral lines comprise a co-polarized doublet and wherein the source of radiation comprises:

a pair of voltage controlled oscillators operating at a s-mmwave frequency and having a first characteristic polarization state;

a set of load-modulated point scatterers that are illuminated by the voltage controlled oscillators, the set of load-modulated point scatterers being preferentially sensitive to the first characteristic polarization state;

wherein the load of each point scatterer is modulated with a time varying signal; and  
wherein the scattered radiation is directed to an object being imaged.

57. The system of claim 52 wherein the source of radiation is in a substrate configuration, the source further comprising means to combine the radiation of the two spectral lines of each component.

58. The system of claim 52 wherein the source of radiation is in a waveguide configuration, the source further comprising means to combine the radiation of the two spectral lines of each component.

59. A method for creating radiation that includes a polarized doublet, the method including:

emitting radiation at a first s-mmwave frequency;

emitting radiation at a second s-mmwave frequency, wherein the difference between the first s-mmwave frequency and the second s-mmwave frequency is much smaller than the average of the first s-mmwave frequency and the second s-mmwave frequency;

polarizing the radiation at the first s-mmwave frequency into a first characteristic polarization;

polarizing the radiation at the s-mmwave frequency into a second characteristic polarization; and

combining the radiation at the first s-mmwave frequency and the radiation at the second s-mmwave frequency; and

directing the combined radiation to a destination.

60. The method of claim 59 wherein the first polarization is essentially equal to the second polarization.
61. The method of claim 59 wherein the first polarization is essentially orthogonal to the second polarization.
62. The method of claim 59 and further comprising controlling the difference between the first s-mmwave frequency and the second s-mmwave frequency.
63. The method of claim 62 wherein the combined radiation is divided into two unequal parts, a major part being directed to the destination and a minor part being used to control the difference frequency.
64. The method of claim 59 and further comprising changing average of the first s-mmwave frequency and the second s-mmwave frequency.
65. The method of claim 59 and further comprising modulating the difference between the first s-mmwave frequency and the second s-mmwave frequency.
66. The method of claim 59 wherein the method is performed in a waveguide configuration.
67. The method of claim 59 wherein the method is performed in a planar substrate configuration.
68. A method of creating radiation that includes a cross-polarized doublet, the method comprising:
  - providing a voltage controlled oscillator operating at a first s-mmwave frequency;

directing energy of the oscillator to uniformly illuminate first and second sets of load-modulated point scatterers, the first set exhibiting a first polarization state and the second set exhibiting a second polarization state, wherein the first polarization state is orthogonal to the second polarization state;

polarizing the oscillator in a third characteristic polarization state;

positioning the first and second sets of point scatterers such that the first and second polarization state substantially differs from the third characteristic polarization state;

modulating the load of the first scatterer with a first time varying signal;

modulating the load of the second scatterer with a second time varying signal, wherein the ground harmonic of first time varying signal essentially differs from any harmonic of the second harmonic time varying signal; and

scattering radiation from the first and second sets of point scatterers.

69. The method of claim 68 wherein the first and second time varying signals are periodic signals.

70. The method of claim 69 wherein the sum of the ground harmonics of the first periodic signal and the second periodic signal is equal to a doublet frequency difference.

71. The method of claim 69 wherein the difference of the ground harmonics of the first periodic signal and the second periodic signal is equal to a doublet frequency difference.

72. The method of claim 69 wherein the periodic signals are binary signals.

73. The method of claim 69 wherein the periodic signals are harmonic signals.

74. The method of claim 69 and further comprising controlling the difference frequency between the periodic signals by dividing the energy of both periodic signals in unequal parts, a major part being used to drive first and second loads and the minor part being used to control the difference frequency.

75. A method of creating radiation that includes a co-polarized doublet, the method comprising:  
providing a voltage controlled oscillator operating at a first s-mmwave frequency;  
polarizing the oscillator in a first characteristic polarization state;  
directing energy of the oscillator to illuminate a modulated point scatterer, the point scatterer being preferentially sensitive to the first characteristic polarization;  
modulating the load of the scatterer with a time varying signal; and  
scattered radiation from the point scatterer.

76. The method of claim 75 wherein the point scatterer is an antenna.

77. The method of claim 75 wherein the point scatterer includes a complex impedance.

78. The method of claim 75 wherein the time varying signal is a periodic signal.

79. The method of claim 78 wherein the periodic signal has a ground harmonic frequency equal to half of a doublet frequency difference.

80. The method of claim 78 wherein the periodic signal has a ground harmonic frequency equal to a doublet frequency difference.

81. The method of claim 78 wherein the periodic signal is a binary signal.

82. The method of claim 78 wherein the periodic signal is a harmonic signal.

83. A millimeter wave transmitter-receiver apparatus for transmitting and receiving image or communication data comprising:

a source of radiation, the radiation comprising a set of independently controllable radiation components, each radiation component comprising a doublet that includes two spectral lines, and each radiation component being labeled by a given frequency shift between the two spectral lines;

a receiver including an array of receiver elements disposed to receive the radiation emitted by the source, the receiver transforming the received radiation into an array of electrical signals; and

a processing system coupled to receive the array of electrical signals and for decoding the array of electrical signals based on the labels of the radiation components.

84. The system of claim 82 wherein the processing system is coupled to the source of radiation to provide instructions on how to control the radiation components.

85. The system of claim 82 wherein the frequency difference between the two spectral lines is modulated.

86. The system of claim 82 wherein the central frequency of the two spectral lines is swept in time.

87. The system of claim 82 wherein the two spectral lines comprise a doublet and wherein the source of radiation comprises:

at least one pair of voltage controlled oscillators operating at different s-mmwave frequencies;

a plurality of paired couplers each of which is individually coupled to an output of one of the voltage-controlled oscillators (VCOs) for dividing VCO radiation into a major portion for transmitting in free space and a minor portion for mixing;

a first mixer for mixing the minor radiation portion the VCO radiation to produce a first beat signal;

a phase locked loop (PLL) circuit providing phase-locking of the first beat signal by the reference signal, wherein one input of the PLL circuit is supplied by the first beat signal, another PLL circuit input is supplied by the reference signal and an output correction voltage produced by the PLL circuits is provided to a frequency correcting driving voltage input of one of the VCOs; and

an antenna system to transmit the major radiation portions produced by the VCOs in free space.